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Incorporating Industrial Organization into Agricultural Trade Modelling

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Introduction

Since the inception of the Uruguay Round of the GATT, research focusing on modelling agricultural trade issues has been an important activity for many economists (e.g. Tyers and Anderson, 1992). The dominant characteristic of this research has been the measurement of the costs of agricultural support policies and the identification of the likely beneficiaries and losers from agricultural policy reform. However, a problem with much of this research has been the failure to incorporate imperfect competition into the modelling of policy reform.

To some extent this has been redressed in recent computable general equilibrium (CGE) modelling work which, by explicitly identifying a role for the food processing sector, has enabled a fuller specification of industry characteristics, i.e. there is a role for economies of scale, product differentiation, free entry and exit and strategic interaction (see Hertel, 1994). In such an environment, agricultural policy reform can generate gains in excess of standard partial equilibrium models, not just due to the general equilibrium effects, but also due to the fact that trade reform can give rise to pro-competitive effects because of changes in market structure.

Despite these recent improvements, a feature common to assessments of agricultural trade policy has been the tendency to assume that all forms of intervention have the same effect on domestic prices. Thus, divergences between world and domestic prices are treated in *ad valorem* form, allowing different forms of intervention to be collapsed into aggregate measures such as producer/consumer subsidy equivalents. If perfect competition is assumed, this does not create a problem, however, if markets are imperfectly competitive, the distinction between policy instruments does matter, as certain instruments, such as import quotas, can affect firms' strategic behavior.

The focus of this paper is on applying recent theoretical developments in the international trade literature that have explicitly examined the effect of different trade policy instruments where markets are oligopolistic. It is shown that an import quota permitting the same level of imports that would enter under a corresponding tariff, can have a very different outcome relative to the tariff policy. This issue is discussed with reference to the recent, and on-going, policy debate regarding changes to the European Community's (EC) banana import regime, where the markets in member states are dominated by a small number of firms. The paper is organized as follows. Section 1 outlines the structure of trade in food and agricultural products, and briefly describes the structure of the food processing sector. Section 2 reviews the literature on the tariff-quota (non-) equivalence issue and the role that market structure may play in influencing the outcome. Section 3 specifies a general conjectural variations model that captures the anticipated effects of tariffs and quotas in oligopolistic settings. Section 4 evaluates the effects of tariffs and quotas on banana imports by one EC member state (Germany), while Section 5 summarizes and concludes.

1. Trade and Market Structure in Food Processing

While agricultural trade modelling has generally ignored issues of market structure, it is not the case that agricultural economists have always assumed perfectly competitive markets. For example, a series of papers, starting with McCalla (1966), and including, among others, Alaouze *et al.* (1978), and Thursby and Thursby (1990), has focused on imperfect competition in the world wheat market. Also, recent research by Karp and Perloff (1989, 1993) has examined the extent of international oligopoly in the rice and coffee markets.

The key departure in this literature has been the recognition of the existence of either government or state trading organizations in international trade. This, however, still ignores the markets for high-value food products where private firms are the main participants. There are two reasons why it is relevant to focus on these markets. First, a large and increasing proportion of international trade in the food and agricultural sector is not in bulk commodities (such as cereals) but in high-value food products. Handy and Henderson (1994) report that, in 1990, the value of world trade in processed food products[1] exceeded $205 billion, a figure that is about three times as large as the value of world trade in bulk agricultural commodities.

Second, high-value food products are manufactured and distributed by private firms operating in markets that can be described as imperfectly competitive. As shown by Connor *et al.* (1985), and Sutton (1991), the food processing industries in both the US and EC do tend to have imperfectly competitive market structures characterized by high seller concentration, some degree of plant level economies of scale, and product differentiation. For example, Sutton (*op.cit.*) reports that the cross-industry, cross-country four-firm sales concentration ratios for the period 1987-88 were, on average, 65% for the food processing sector. Generally, the food processing industries, in both the US and EC, are dominated by small numbers of firms, suggesting that there is potential for strategic interaction.

In addition, work by Hirschberg *et al.* (1994), indicates that a good deal of trade in food processing is of an intra-industry nature, a pattern which is normally rationalized by appeal to factors such as imperfect competition, economies of scale and product differentiation (see Helpman and Krugman, 1985). Therefore, while it is an empirical matter to establish exactly the

[1] Defined as industries classified into the 2-digit SIC Code 20.

degree to which food processing firms are acting less than competitively, it seems reasonable to argue that, *a priori*, given the available evidence, it is important to incorporate industrial organization analysis into agricultural trade modelling exercises, particularly the impact of market structure on the outcome of trade reform.

2. Tariffs, Quotas and Firms' Behavior

Much of the recent trade policy literature that deals with oligopolistic markets has focused on tariffs and subsidies as the relevant trade instrument[2]. However, most trade instruments in the agricultural and food sectors consist of non-tariff barriers (NTBs) such as import quotas. MacBean (1989) has shown that, in the 1980s, over 40 percent of total agricultural imports by developed countries were affected by some sort of NTB. For example, the dairy industry in the US is protected by a system of import quotas (see Anderson, 1985), likewise, the EC sugar regime (see Harris *et al.*, 1983). Hence, it is important, in considering policy reform in the food and agricultural sectors, to understand the consequences of using quantity constraints and to compare these with the effects of instruments such as tariffs.

The early literature on the equivalence[3] between tariffs and quotas as alternative trade policy instruments considered two extremes of market structure in the importing country; perfect competition and monopoly (see Bhagwati, 1965, 1968; and Shibata, 1968). The upshot of this research was to show that market structure matters since, given that the quota-induced demand curve facing the domestic monopolist lies below the initial demand curve, domestic prices will

[2] See for example, Brander and Spencer (1985).

[3] 'Equivalence' relates to the effect on domestic prices when the level of imports permitted with a quota is the same as that due to a tariff.

be higher with a quota relative to a tariff, i.e. tariffs and quotas are non-equivalent under monopoly.

More recent literature has considered the tariff-quota issue in intermediate cases, i.e. where markets are oligopolistic. For example, Harris (1985), and Krishna (1989) analyze the effects of quantitative restraints when firms play a game in price. The seminal paper by Krishna (*op.cit.*) illustrates the non-equivalence argument most starkly[4]. Consider **Figure 1**, RF_1 and RF_2 represent the usual reaction functions in a price game where the products are strategic complements, and N is the initial Bertrand-Nash equilibrium. Taking a demand function, and assuming a quota is imposed on firm 2 at $\bar{x}_2$, this constraint binds at prices p_1 and p_2 if:

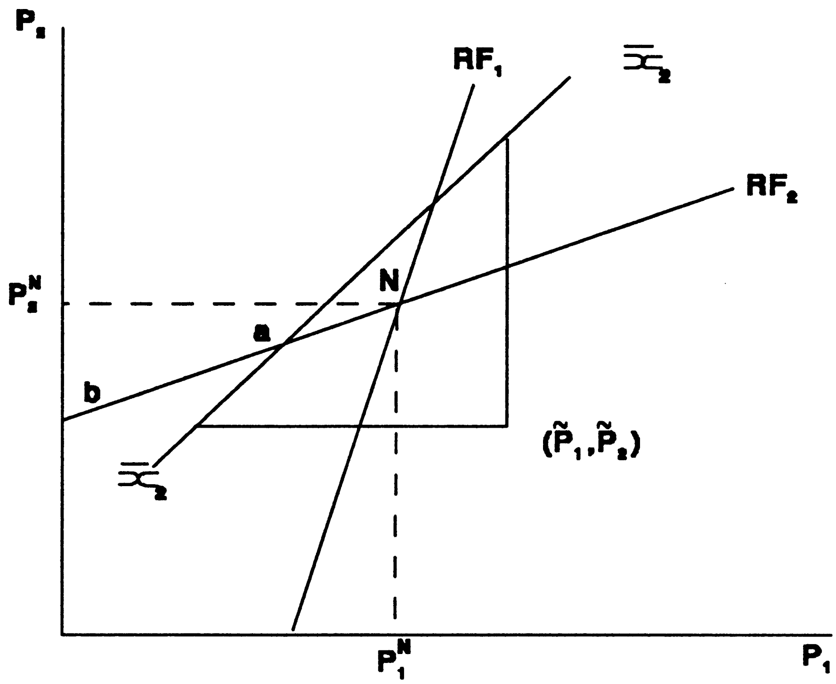
$$\overline{x_2} = D_2(p_1,p_2) \tag{1}$$

This implicitly defines the price p_2 that will just satisfy the quota constraint given firm 1's price p_1, i.e. $p_2 = f(p_1,\bar{x}_2)$. The set of prices that will satisfy the quota constraint is given by the line $\bar{x}_2\bar{x}_2$ in the figure. This line lies to the left of the unconstrained equilibrium as the quota, by definition, is more restrictive. It is also upward-sloping because if firm 1 increases its price, firm 2 must raise its price in order to satisfy the constraint. At points to the right of $\bar{x}_2\bar{x}_2$, firm 2's price is lower than that necessary to be consistent with the quota constraint, and hence the quota constraint is binding. At points to the left of $\bar{x}_2\bar{x}_2$, the quota constraint is not binding. So firm 2's reaction function is the line denoted $ba\bar{x}_2$. To illustrate, suppose that firm 1 charges $\tilde{p}_1$ and firm 2 charges $\tilde{p}_2$, demand for firm 2's processed product will exceed the constraint. It is

[4] The key difference between these papers is that while Krishna maintains a simultaneous-move game, Harris assumes that a quota turns the domestic and foreign firms into Stackelberg leader and follower respectively.

assumed that costless arbitrage occurs whereby consumers of firm 2's good who are able to purchase at $\tilde{p}_2$, re-sell at a higher price that clears the market[5].

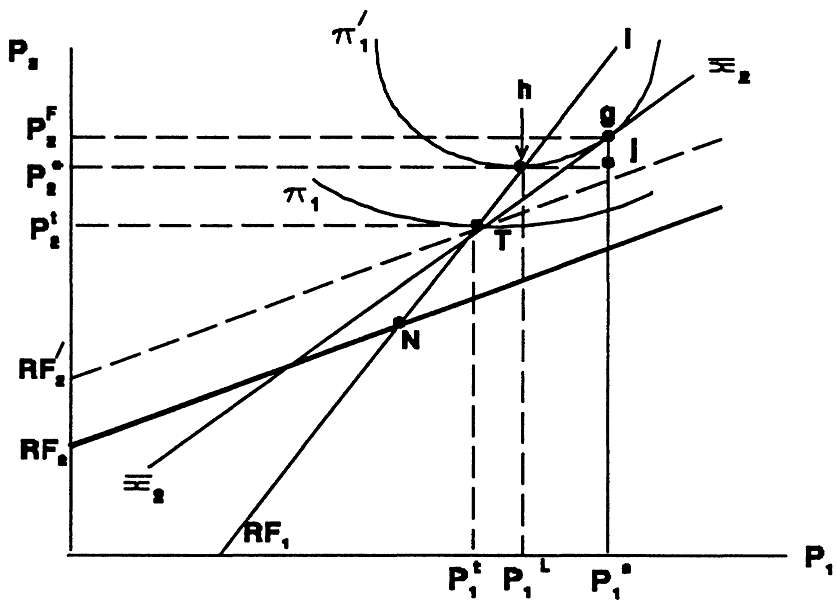
Figure 1



Given firm 2's reaction function under the quota constraint, firm 1's reaction function is considered in **Figure 2**. Define two price combinations: (p_2^F, p_1^s) where firm 1's iso-profit contour π_1' is just tangent to the quota constraint at **g**, and (p_2^*, p_1^L) where π_1' intersects firm 1's reaction function at **h**. If firm 2 sets a price $p_2 > p_2^*$, then firm 1 is unaffected by firm 2's quota constraint as it can sell at a price along its reaction function **hi** which generates profits in excess of π_1'. If $p_2 < p_2^*$, firm 1 will set its price at p_1^s which is consistent with firm 2's constraint. If $p_2 = p_2^*$, firm 1 is indifferent between setting p_1^s and p_1^L, as it can obtain π_1' at either price level.

[5] Tirole (1989) refers to this as an 'efficient' rationing rule, as it maximizes consumer surplus.

Figure 2



Consequently, firm 1's reaction function is discontinuous between the points **h** and **j**, and so never intersects firm 2's reaction function. Therefore, a Nash equilibrium in pure strategies does not exist[6]. As Krishna (*ibid*) shows, a mixed strategy equilibrium does exist where firm 2 charges p_2^* while firm 1 randomizes over the prices p_1^L and p_1^s. In the mixed strategy equilibrium, firm 2's expected profits rise to the level associated with p_2^*, while those of firm 1 rise to π_1'. Also, as these prices exceed those at the initial Bertrand-Nash equilibrium, the output of both firms is likely to fall. In addition, these effects are not equivalent to those under a tariff. The tariff-equivalent to the quota would be at point T, where the foreign firm's reaction function has been shifted up by the amount of the tariff. Clearly, equilibrium prices are lower here than under the quota.

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[6] A quota restriction here is like a capacity constraint, and, since Edgeworth (1925), it has been known that capacity constraints in a Bertrand game will not result in a pure strategy equilibrium.

However, it turns out that this result is sensitive to the assumption that firms play a game in price. Specifically, Fung (1989) has shown that if firms play Nash in quantities, and the goods are strategic substitutes, tariffs and quotas are equivalent. While this result is not shown in detail here, it does illustrate a dilemma for empirical research. Specifically, imposing a particular form of oligopolistic interaction on an international market may result in the incorrect evaluation of an NTB's impact.

A possible solution to the problem can be found in the work of Hwang and Mai (1988). They show that in a general conjectural variations model, quantitative restraints can generate either pro- or anti-competitive effects, or neither, depending on the initial values of the firms' conjectures, i.e. how (un)competitive the market was prior to the imposition of the quota. In their duopoly model, a quota effectively imposes Cournot behavior on the home firm, i.e. the home firm now knows that if it changes its output, the foreign firm's output cannot change, presuming the quota is binding, which is effectively identical to what is assumed under Cournot behavior. Hence, if the firm was initially playing more (less) competitively than Cournot, then a quota will make the market less (more) competitive. In this context, the quota can have either pro- or anti-competitive effects. In the case where firms initially play Cournot, the quota has no effect on firms' behavior, and, thus, the tariff and quota are equivalent (the Fung result).

In sum, when markets are oligopolistic, tariffs and quotas are likely to be non-equivalent since quotas affect firms' behavior while tariffs do not. Consequently, when modelling imperfectly competitive markets, dealing with alternative trade policy instruments in *ad valorem* form ignores a potentially important effect of trade policy intervention. How important this issue is and what influences the degree of non-equivalence is explored in the remainder of the paper.

3. Theoretical Framework

(a) Basic Model

The model of oligopoly used here, and subsequently applied to the German banana market, is a standard model of differentiated oligopoly utilized by, among others, Dixit (1988), and Cheng (1987). There are two principal reasons for adopting this model: first, it follows a general conjectural variations approach so that the effect of quotas on firms' conjectures can be considered; second, following Dixit (1987), the model can be used to generate an empirical assessment of the effect of trade policies.

The structure of the market is divided into two where dominant firm(s) compete with fringe firms in the domestic market, although there is no domestic production. The dominant firm(s) output is denoted by subscript 1, fringe output by subscript 2. Consumer surplus is given by:

$$\Gamma = f(Q_1,Q_2) - p_1Q_1 - p_2Q_2 \tag{2}$$

where the utility function $f(Q_1,Q_2)$ is defined as:

$$f(Q_1,Q_2) = a_1Q_1 + a_2Q_2 - (b_1Q_1^2 + b_2Q_2^2 + 2kQ_1Q_2)/2 \tag{3}$$

These functional forms generate the following inverse demand functions:

$$p_1 = a_1 - b_1Q_1 - kQ_2 \tag{4}$$

$$p_2 = a_2 - b_2Q_2 - kQ_1 \tag{5}$$

where all the parameters are positive, p_1 and p_2 are prices, Q_1 and Q_2 are quantities and $b_1b_2 - k^2 \geq 0$ indicates the extent to which dominant and fringe goods are imperfect substitutes.

On the supply side, there are n_i symmetric-sized firms in the dominant and fringe sectors. Since in the empirical example to follow the market is characterized by the dominance of multinational firms, it is assumed that profits are repatriated abroad. Thus, profits do not enter the domestic welfare function. Firms' costs are assumed constant. Profits for a representative firm in each sector are given by:

$$\pi_1 = (p_1 - c_1 - t)q_1 - f_1 \tag{6}$$

$$\pi_2 = (p_2 - c_2 - t)q_2 - f_2 \tag{7}$$

where c_i and f_i are marginal and fixed costs respectively and t is a tariff. Since there are n_i firms in each sector, such that aggregate output can be given by $Q_i(= n_i q_i)$, the first-order conditions for profit maximization are:

$$p_1 - c_1 - t - Q_1 V_1 = 0 \tag{8}$$

$$p_2 - c_2 - t - Q_2 V_2 = 0 \tag{9}$$

where the aggregate conjectural variation parameters V_i are explicitly given by:

$$V_1 = [D_1^1\{1 + (n_1 - 1)v_{11}\} + D_2^1 n_2 v_{12}]/n_1 \tag{10}$$

$$V_2 = [D_1^2\{1 + (n_2 - 1)v_{22}\} + D_2^2 n_1 v_{21}]/n_2 \tag{11}$$

where D_i^i (i = 1,2) are the partial derivatives ($\delta p_i / \delta Q_i$) with respect to dominant and fringe firm produced goods, and v_{ii} (i = 1,2) are the firms' conjectures about how dominant and fringe competitors will respond to a change in quantities. The values for the v_{ii}'s are continuous variables whose values capture a range of possibilities concerning firm behavior. For example, if the dominant and fringe firms play Cournot strategies, then all v_{ii}'s will equal zero; hence the values of V_1 and V_2 will equal D_1^1 / n_1 and D_2^2 / n_2 respectively. For conduct more competitive (less competitive) than Cournot, $v_{ii} < 0$ ($v_{ii} > 0$). In the limit, $v_{ii} = -1$, the competitive outcome, or $v_{ii} = 1$, the collusive outcome. Clearly firms can hold different conjectures about their competitors in the dominant and fringe sectors.

Equilibrium prices and quantities are obtained by combining (4), (5), (8) and (9) to give:

$$\begin{bmatrix} Q_1 \\ Q_2 \end{bmatrix} = \frac{1}{\Delta'} \begin{bmatrix} b_2 + V_2 & -k \\ -k & b_1 + V_1 \end{bmatrix} \begin{bmatrix} a_1 - c_1 - t \\ a_2 - c_2 - t \end{bmatrix} \tag{12}$$

$$\begin{bmatrix} p_1 \\ p_2 \end{bmatrix} = \begin{bmatrix} a_1 \\ a_2 \end{bmatrix} - \frac{1}{\Delta'} \begin{bmatrix} \Delta + b_1 V_2 & kV_1 \\ kV_2 & \Delta + b_2 V_1 \end{bmatrix} \begin{bmatrix} a_1 - c_1 - t \\ a_2 - c_2 - t \end{bmatrix} \tag{13}$$

where $\Delta = (b_1 b_2 - k^2)$ and $\Delta' = (b_1+V_1)(b_2+V_2)-k^2$.

(b) Effects of a Quota

The effect of an import quota can be broken down into two parts: an *ad valorem* effect and a firm behavioral effect. The *ad valorem* effect acts like the tariff since, for the same quantity of imports, consumer prices will rise. Thus, from expression (13), it can be readily shown that differentiating p_1 and p_2 with respect to t:

$$\frac{dp_1}{dt} + \frac{dp_2}{dt} > 0 \tag{14}$$

i.e. domestic prices rise when a tariff is imposed. However, as Hwang and Mai suggest, a quota can change firms' behavior which, in this model, is characterized by a change in firms' conjectures. Thus, if the quota affects all firms (which is the case in the particular example to follow), then, for a given tariff, it can be shown that there will be an additional effect on prices:

$$\left.\frac{dp_1}{dv_{11} + dv_{12}}\right|_t + \left.\frac{dp_2}{dv_{21} + dv_{22}}\right|_t > 0 \tag{15}$$

The direction of change in p_1 and p_2 will depend on the initial value of firms' conjectures. If all firms were initially playing Cournot (i.e. $v_{11} = v_{12} = v_{21} = v_{22} = 0$) then tariffs and quotas would be equivalent since there would be no change in firms' conjectures induced by the quota. However, if the conjectures initially differed from zero (i.e. $v_{11}, v_{12}, v_{21}, v_{22} \gtrless 0$), then tariffs and quotas would be non-equivalent since the quota now has the additional effect of making the conjectures take the Cournot value. Of course, each of the conjectures could initially be positive or negative (e.g. $v_{11}, v_{12} > 0$ and $v_{21}, v_{22} < 0$ or any other combination), then the net effect will be the sum of the subsequent changes[7]. Also, inspection of the firms' first-order conditions (8) and (9), and the conjectural variations expressions (10) and (11) indicates that firms' output under the quota, and hence prices, will vary not only in the initial values of the v_{ii} terms but also the number of firms n_i, and the demand parameters b_i and k. In terms of the calibration of this model, the demand parameters will be affected by the values chosen for the elasticities of demand and substitution, ε and σ respectively.

In terms of domestic welfare, therefore, quotas can exacerbate or offset the effects of tariffs. However, there is one additional consideration. With tariffs, there can be 'rent-shifting' effects, where rents are shifted form foreign to home firms[8]. In most models, this relies on sufficiently strong terms of trade effects, though in the example to follow, it could arise if the

[7] Of course, it is possible that even with initial conjectures being different from zero, the pro- and anti-competitive effects could cancel each other.

[8] See Helpman and Krugman (1989) for a discussion of the rent-shifting effects of trade policy instruments.

government collects tariff revenue from the dominant and fringe firms (since neither of these are domestic producers). Thus defining welfare to be the sum of consumer surplus and tariff revenue on all imports (Q_1 and Q_2), then it is possible that:

$$\frac{dW}{dt} > 0 \tag{16}$$

However, with quantitative restraints, unless the quota licenses are auctioned, the quota rent would not be retained domestically. In this case, domestic welfare (now defined only as consumer surplus) falls.

4. Empirical Assessment

(a) Methodology

The empirical results presented below are derived using a computable partial equilibrium model based on the theoretical framework outlined. As details of this technique are discussed elsewhere (Dixit, 1987), a full outline of the procedure is not presented here. Essentially, calibrating this system involves using estimates of the elasticity of demand ε, the elasticity of substitution σ, and observations on prices, quantities and costs so that the parameters are consistent with equilibrium in any given period. Once this is done, the effects of policy changes can be derived by using equations (12) and (13), the changes in consumer surplus being found by using equation (2).

(b) Application

This methodology is applied to the German banana market. The rationale for focusing on bananas, and the German market in particular, is twofold. The key feature of the world banana export industry is the dominance of three multinational firms - United Brands (Chiquita), Standard Fruit (Dole), and Del Monte (see Read, 1983). Between them, these three firms account for 70 percent of the world market and 66 percent of the European market, United Brands alone accounting for 43 percent (Hallam and McCorriston, 1992). In individual EC states, markets are also highly concentrated. For example, in Germany, three firms (United Brands, Standard Fruit and Noboa) account for 72 percent of the market. In addition, product differentiation through branding is a key feature of the retailing of bananas. For example, United Brands are reported to be able to sell their Chiquita brand at a price on average between 30 to 40 percent higher than its unbranded bananas (European Commission, 1976). Further evidence of possible market power in the EC is given by the European Commission's 1976 and 1992 rulings against United Brands that it had abused its dominant market position.

Second, while Germany is the only EC member state that has operated a free market system in banana trade, since the end of 1992, reform of the EC banana import regime, designed to harmonize internal EC banana prices, has led to Germany having to implement trade restrictions on its banana imports[9].

The model described in Section 3 was calibrated with the most recent available German banana data for 1991. The relevant price, quantity and elasticity data were derived from FAO Banana Statistics (1992), Borrell and Yang (1992), and Islam and Subramian (1989) respectively;

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[9] While Germany has operated a regime of free trade in bananas, countries such as France, Spain and the United Kingdom have maintained restrictions on imports from so-called Dollar countries (e.g. Columbia and Ecuador etc.) in order to ensure high prices for preferential suppliers of bananas from the African, Caribbean and Pacific states. As a result there has been wide variation in retail banana prices across the Community, which would be unsustainable under the EC's 1992 Single Market process. The policy that was actually introduced in December 1992 was a combination of tariffs and quotas. For the first 2 million tonnes, bananas will enter the EC at a reduced duty, thereafter, the tariff rises to a prohibitive 170 percent. For more detailed discussion of the debate over the EC's banana import regime, see: Borrell and Yang (1990, 1992), Fitzpatrick and Associates (1990), Hallam and McCorriston (1992).

p_1 = 1491 DM/tonne, p_2 = 1228 DM/tonne, Q_1 = 542,080 tonnes, Q_2 = 813,120 tonnes, ε = -0.4, and σ = 3.0.

(c) Results

The EC Commission's policy options varied between tariffs and quotas. In order to evaluate the degree of non-equivalence, it is assumed that the EC-wide tariff chosen is 20 percent or, alternatively, that the EC imposes quantitative restraints on banana imports at the 20 percent tariff-equivalent level[10]. The results of simulating these policies in the German banana market are given in **Table 1**. When a tariff is imposed, it would reduce German consumers' welfare, the estimated reduction here being DM 482.4 million, a reduction of approximately 20 percent. Overall welfare for Germany is reduced by this amount even though the 20 percent tariff raises revenue; this, however, becomes part of EC budgetary resources. Even if it were retained in Germany, welfare shows a small net decline as the loss to consumers from the increase in banana prices outweighs the increase in tariff revenue - there are of course no rent-shifting effects here as none of the banana firms are German-based. Firms supplying the German market would face a reduction in profits of DM 31.5 million.

Table 1: Effect of Tariffs and Quotas on the German Banana Market (DM million)

Simulation	Consumer Welfare	Firms' Profits	Tariff Revenue
Baseline	2465.5	303.8	-
20% Tariff	1983.1	272.3	281.2
20% Tariff -Equivalent Quota	1604.4	735.2	-

[10] Effectively, the prohibitive tariff of 170 percent on imports in excess of 2 million tonnes makes the policy a binding quota, and the tariff is being used to collect the quota rents.

Importantly though, as discussed above, the quota-equivalent policy is likely to have different effects since not only will it have an *ad valorem* effect, but it will also change firms' behavior unless they are already playing Cournot. As **Table 2** indicates, both the dominant firm and the fringe firms (in aggregate) were playing more competitively than Cournot during the period of calibration.

Table 2: Estimated Conjectural Variations Parameters

	Actual	Cournot-Equivalent
Dominant Firm (V_1)	.00070469	.0056096
Fringe Firms (V_2)	.00014635	.00022295

Therefore, with the imposition of a quota, both sets of firms now play less competitively. Domestic prices, therefore, rise by a greater amount than in the tariff case and consumers' welfare is reduced further. **Table 1** shows that, relative to the baseline, consumer welfare is reduced by DM 861.1 million, a reduction of 35 percent. Further, unless the quota licenses are auctioned, quota rents are captured by the supplying firms whose profits now increase by 142 percent relative to the baseline case and by 170 percent relative to the tariff case. Clearly, at least in this example, the non-equivalence between tariffs and quotas is substantial[11].

(d) Sensitivity Analysis

Clearly the simulated degree of non-equivalence between tariffs and quotas is likely to be sensitive to the values of the elasticities used to calibrate the model. In common with most calibration exercises (e.g. Dixit, 1987), this issue is explored by varying the values for the values of the elasticity of demand and elasticity of substitution parameters. The results of this exercise

[11] In their study of protection in the EC car market, Digby *et al.* (1988) also found that voluntary export restraints gave rise to considerable anti-competitive effects.

are reported in **Table 3,** where non-equivalence between the tariff and quota is indexed by the percentage difference between prices under the tariff and the tariff-equivalent quota, the prices of the dominant and fringe firms having been averaged. The results indicate that as either ε or σ are increased for constant values of the other, the degree of non-equivalence decreases, i.e. the effect of increased product substitutability and price elasticity of demand tempers the effects of firms acting less competitively under a quota. In particular, the degree of non-equivalence declines rapidly for increases in the elasticity of demand, suggesting that the inelastic demand for bananas significantly affects the policy outcome between tariffs and quotas. These results highlight the importance of doing sensitivity analysis when conducting policy simulations of this type.

Table 3: Sensitivity Analysis for Degree of Non-Equivalence between Tariffs and Quotas[1]

		Elasticity of Substitution σ		
		1.5	2.0	3.0
	0.4	39.3	33.2	26.5[2]
Elasticity of Demand ε	1.0	9.7	6.2	4.9
	1.5	3.6	2.1	0.5

[1] Percentage difference between tariff and quota prices, averaged over the dominant and fringe firms.

[2] This is the degree of non-equivalence derived in the simulation.

5. Summary

This paper has focused on how of market structure can affect the outcome of trade policy. While there have been some recent attempts to deal with market structure issues in agricultural trade policy analysis, there has, as yet, been little discussion of the effects of alternative trade policy instruments. It has been shown that quantitative restraints in oligopolistic markets are likely to have different effects relative to the equivalent level of imports induced by a tariff. The reason for this is that a quantitative measure will likely change firms' behavior while a tariff will leave it unchanged.

This issue was explored in the context of the changes proposed to the EC's banana market regime. In the empirical assessment of trade measures applied to the German market, it was shown that the anti-competitive effects would outweigh the *ad valorem* and tariff revenue (if applicable) effects. However, it may be possible that pro-competitive effects could be the dominant feature in other case-studies. In sum, in analyzing the effect of trade policy in oligopolistic environments, it is necessary to take account of the trade instrument used. Focusing just on *ad valorem* equivalents may not capture the whole story.

Finally, while this paper has emphasized the importance of capturing market structure in trade policy modelling, the analysis is characterized by a weakness of virtually all empirical work on industrial organization and trade, the use of conjectural variations to measure oligopolistic interaction. Conjectural variations have long been regarded as an unsatisfactory way of modelling oligopoly, the standard objection being that they represent an attempt to impose dynamic interaction of firms on a single-period game (Friedman, 1977; Tirole, *op.cit.*). A static game, by definition, cannot allow firms to react to one another, so the notion of firms having beliefs about their rivals' reactions is unsatisfactory. In addition, as Dixit (1988) has pointed out, when conducting comparative statics exercises with calibration models, the conjectural variations parameters tend to be fixed irrespective of the policy instrument used.

While the analysis presented in this paper attempts to deal with the latter problem by adjusting the conjectural variations parameters in response to the use of import controls, this still does not get around the general problem raised by theorists about using conjectural variations. Although recent theoretical work by Dockner (1992) indicates that perhaps a conjectural variations equilibrium does capture dynamic interactions. Using a linear-quadratic structure, Dockner shows that a steady-state closed-loop equilibrium for a dynamic game can be viewed as a conjectural variations equilibrium of the corresponding static game, and, therefore, conjectural variations may be a reasonable approximation in empirical work.

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